

WATER RESOURCES ACTIVITIES

IN KENTUCKY, 1986

Compiled by Robert J. Faust

U.S. GEOLOGICAL SURVEY

Open-File Report 86-71

Louisville, Kentucky

1986



UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
Water Resources Division
Stoddard Johnston Building
2301 Bradley Avenue
Louisville, Kentucky 40217

Copies of this report
can be purchased from:

Open-File Services Section
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INTRODUCTION

Message from the District Chief

The U.S. Geological Survey, Water Resources Division, established its first stream gaging stations in Kentucky in 1905. Ground-water investigations started in 1943 with initial investigations in the Louisville area. I am very proud of the accomplishments of the Survey during these years and honored to be directing its current activities. Although these are difficult times in the Federal and Commonwealth governments, the needs for water-resources data are ever increasing. The Survey will continue to play an important role in fulfilling these water-data needs.

During the 1985 fiscal year, the District completed several investigations and initiated three others. A record number of reports were completed and (or) published, climaxing an intense effort to publish our data on a near-current basis.

During the 1986 fiscal year, much of our effort is being devoted to work on the water resources of the Kentucky River basin. This is an area of expanding population and industrial development. Water-resources information is needed to manage, protect, and meet the increasing water demands. Other projects are in progress at Louisville, Elizabethtown, and at Maxey Flats low-level waste-disposal site.

Alfred L. Knight
District Chief

U.S. Geological Survey Origin

"The U.S. Geological Survey was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific 'classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain.' An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the USGS has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the USGS has become the Federal Government's largest earth-science research agency, the Nation's largest civilian map making agency, the primary source of data on the Nation's surface- and ground-water resources, and the employer of the largest number of professional earth scientists. Today's programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.
- Conducting water-resource appraisals in order to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.
- Providing earth-science information through an extensive publications program and a network of public access points.

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the USGS remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing 'Earth Science in the public Service.'"

Basic Mission and Program of the
Water Resources Division

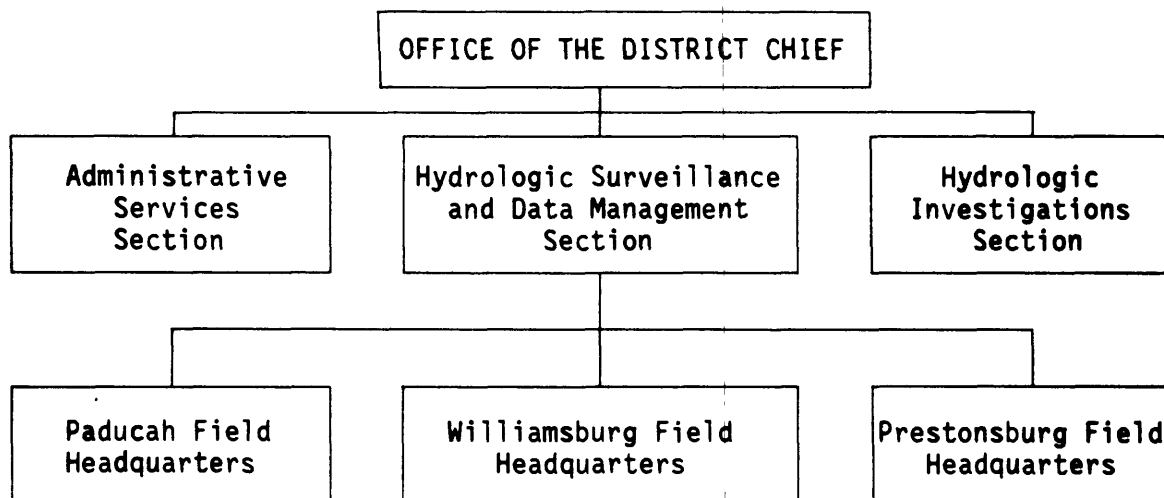
"The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people in the United States.

This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

- Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- Conducting analytical and interpretive water-resources appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface and ground water.
- Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade.
- Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.
- Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground waters.

Providing scientific and technical assistance in hydrologic fields to other Federal, State and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State."

Kentucky District Organization



KENTUCKY DISTRICT ADDRESSES

Inquiries regarding activities described in this report may be directed to the District Office or Field Headquarters in which the work originated.

District Office (502) 582-5241
Alfred L. Knight
District Chief

U.S. Geological Survey
Stoddard Johnston Building
2301 Bradley Avenue
Louisville, Kentucky 40217

Paducah Field Headquarters
Vacancy
Technician in Charge

U.S. Geological Survey
P.O. Box 770
Paducah, Kentucky 42002

Williamsburg Field Headquarters
Franklin D. King
Technician in Charge

U.S. Geological Survey
P.O. Box 1028
Williamsburg, Kentucky 40769

Prestonsburg Field Headquarters
Zeke Hensley
Technician in Charge

U.S. Geological Survey
HCR 70, Box 540
Van Lear, Kentucky 41265

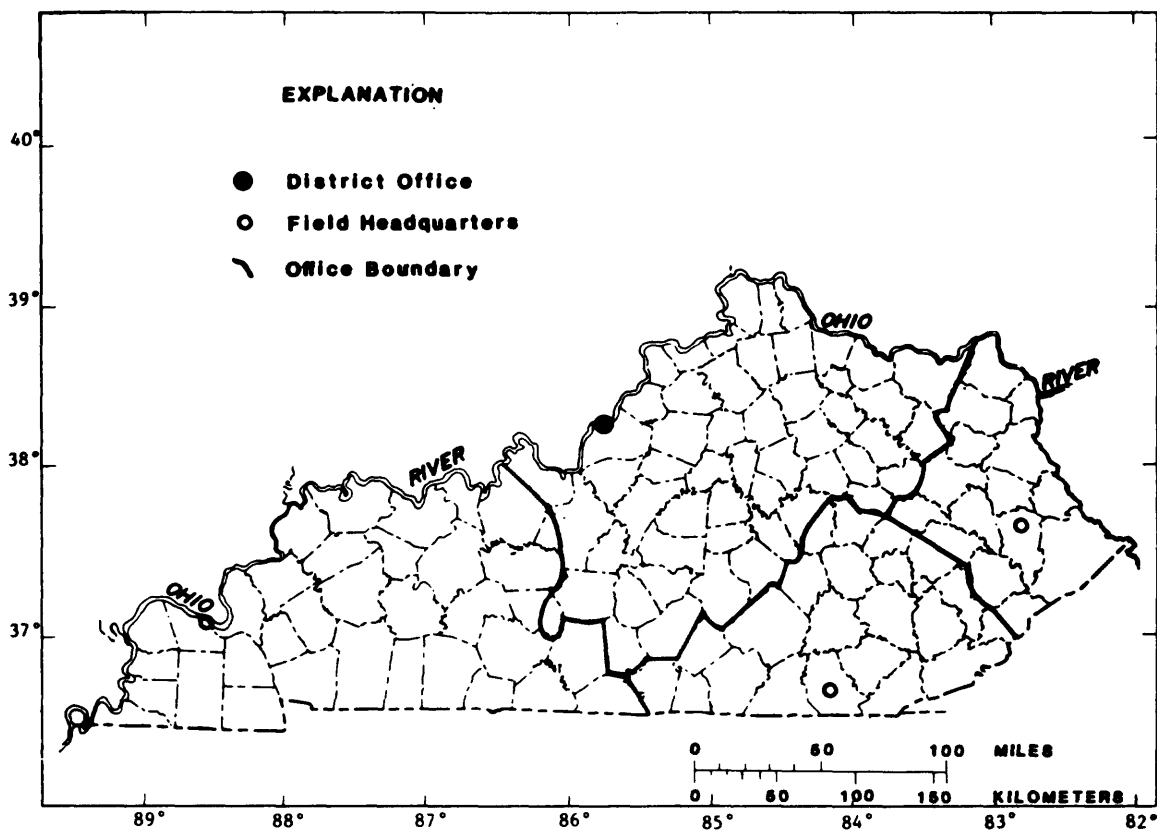
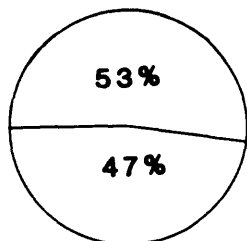


Figure 1.--Location of offices in Kentucky.

TYPES OF FUNDING

The diagram below shows the percentage of the investigations for fiscal year 1986 in the broad categories of collection of hydrologic data and interpretive studies:

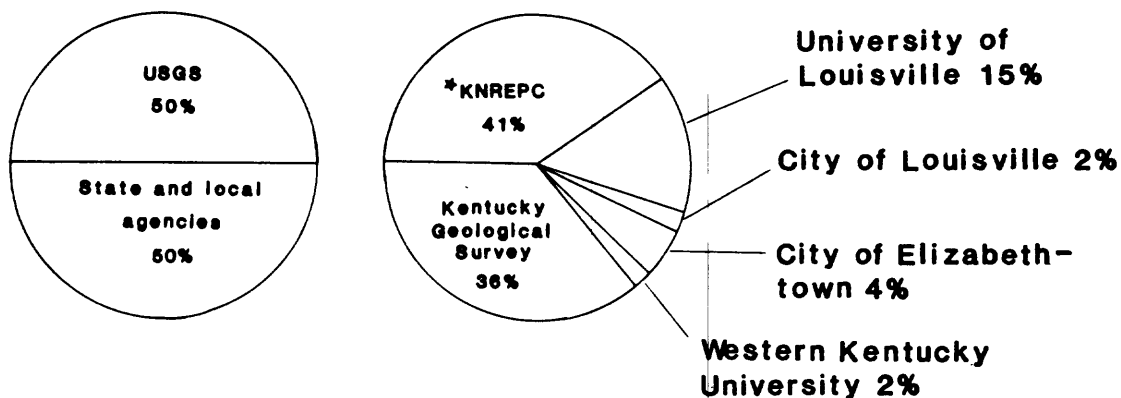


Collection of hydrologic data

Interpretive studies

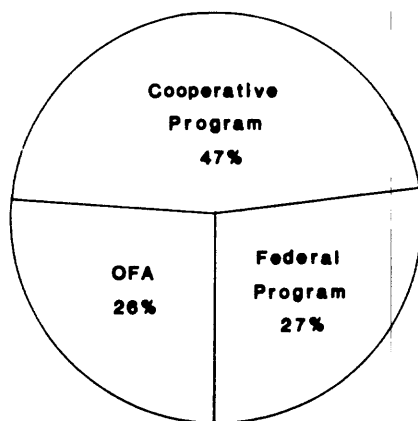
The investigations are directed toward obtaining the information needed by managers and planners for the solution or alleviation of water problems in the State.

The investigations are supported by services and (or) funds provided by State and other agencies, matched on a 50-50 basis by Federal funds (cooperative program). In fiscal year 1986 the financial support for these programs in Kentucky was about \$1,399,396 which was distributed as follows:



* Kentucky Natural Resources and Environmental Protection Cabinet

Also funds are transferred from other Federal agencies (OFA program), and are appropriated directly to the Geological Survey (Federal program). In 1986 the entire program was \$2,974,996 and was distributed as follows:



COOPERATING AGENCIES

Table 1.--Agencies supporting water-resources investigations
during fiscal year 1986

State Agencies

Kentucky Geological Survey (KGS)
Kentucky Natural Resources and Environmental Protection
Cabinet (KNREPC)
 Division of Water
 Office of Surface Mining
Kentucky Transportation Cabinet

Local Agencies

City of Elizabethtown
City of Louisville
Kentucky Utilities
Public Service Indiana
University of Louisville
Western Kentucky University

Federal Agencies

Department of the Army
 U.S. Corps of Engineers
 Huntington District
 Louisville District
 Nashville District
Department of the Interior
 Office of Surface Mining (OSM)
Federal Emergency Management Agency (FEMA)
Tennessee Valley Authority (TVA)

WATER CONDITIONS

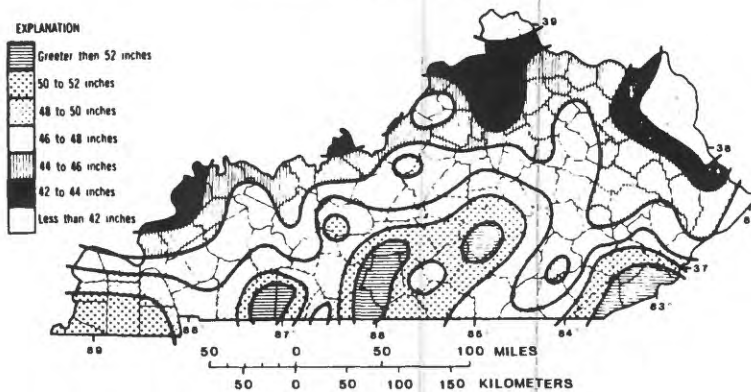


Figure 2.--Mean annual precipitation 1948-77. (From Kentucky Climate Center, Western Kentucky University)

Kentucky has an abundance of water because precipitation averages about 40 inches in the northernmost part of the State and about 52 inches in the southern part. However, because of seasonal and areal variations in precipitation and areal variations in geology and topography, some areas experience water shortages during summer and during drought periods.

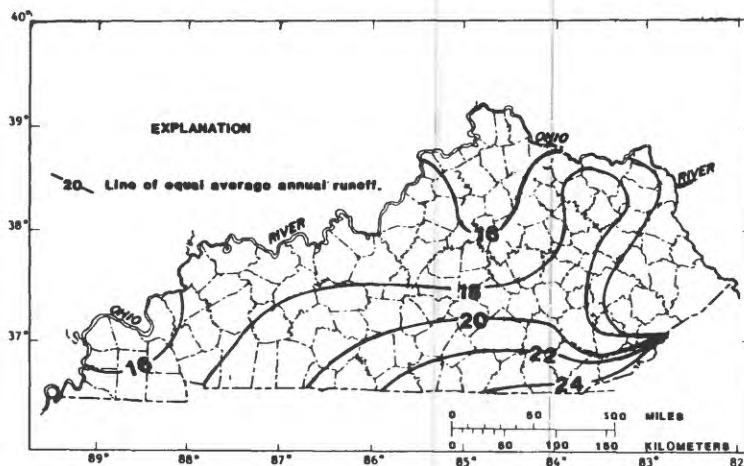


Figure 3.--Average annual runoff, in inches.

Runoff in Kentucky ranges from less than 16 inches in the northern part to about 26 inches in the southeastern part. It averages about 18 inches for the State and is lowest during June through October and highest during March.

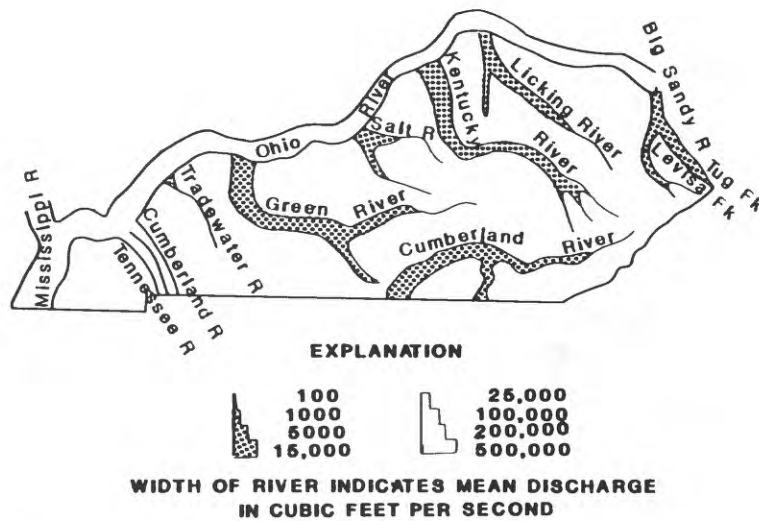


Figure 4.--Mean discharge of major rivers.

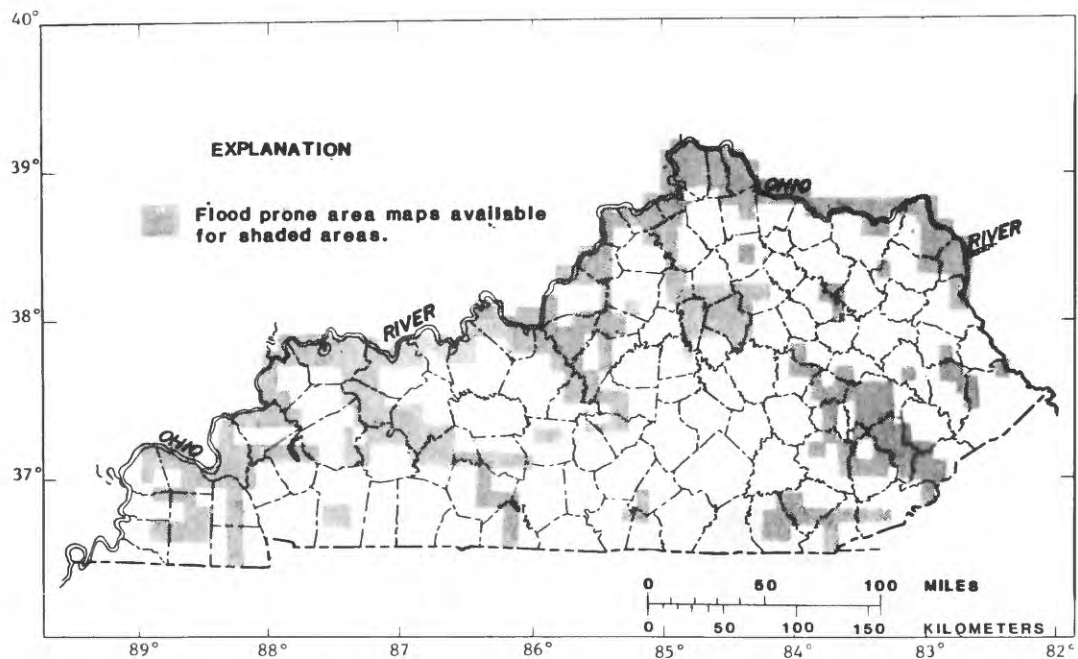


Figure 5.--Flood-prone area maps completed in Kentucky.

Flooding is a recurring problem along many streams in Kentucky. Major floods occur more frequently from November to May but flash floods can occur at any time. An index to flood-prone area maps is shown. More detailed maps, done for flood insurance studies, are available for some of the more heavily populated areas of the State.

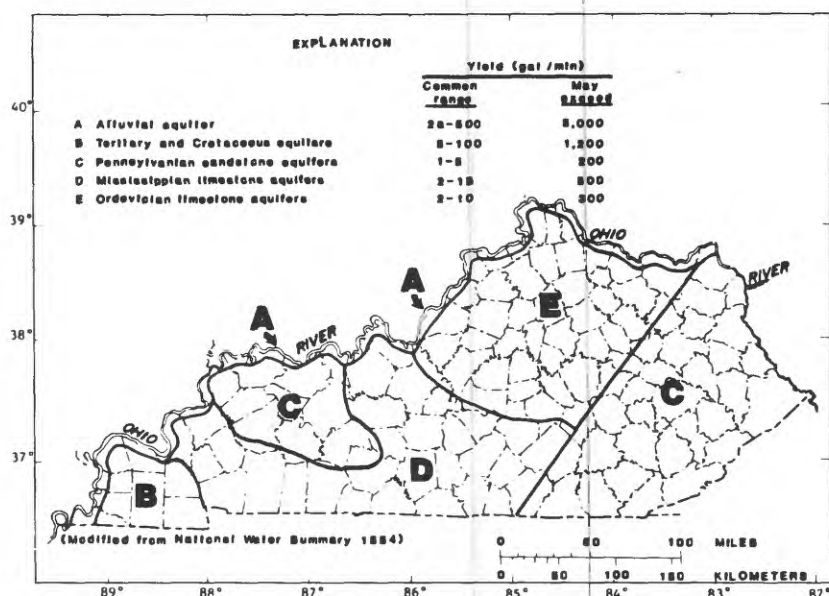


Figure 6.--Principal aquifers in Kentucky.

The principal aquifers as modified from the National Water Summary 1984 (p. 2275) are shown in the above map. The table above the map gives the common and maximum yields of the aquifers.

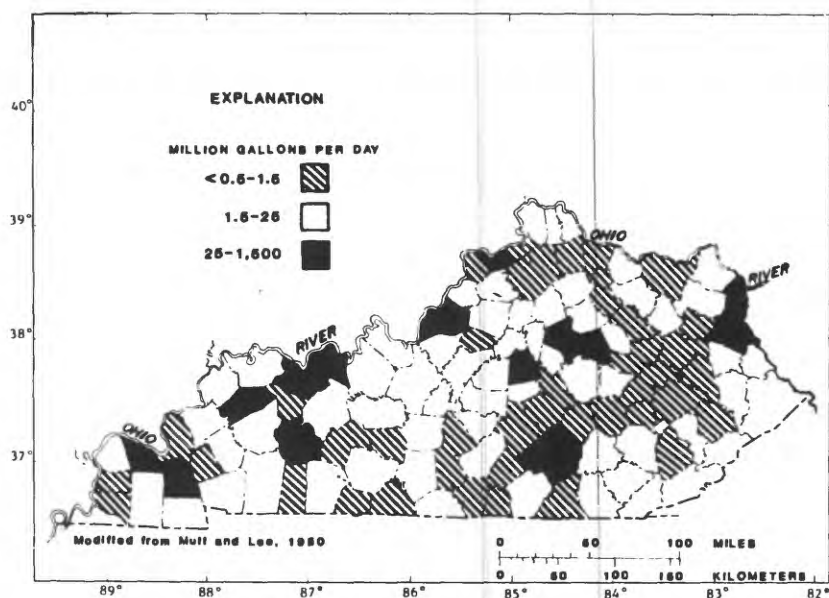


Figure 7.--Water use in Kentucky.

Water use in Kentucky is shown in the above map. Most counties that use significant quantities of water are along the larger streams in the State or along the bordering rivers.

WATER-RESOURCES ACTIVITIES

The U.S. Geological Survey, Water Resources Division, conducts three major types of activities in Kentucky in order to provide hydrologic information and understanding needed for the best management of Kentucky's and the Nation's water resources. These activities are listed below and described in the remainder of this section:

1. Data collection and dissemination
2. Water-resources appraisals (interpretive studies)
3. Research

KY 00-001 SURFACE-WATER STATIONS

LOCATION: Statewide--See figure 8 for location of sites



PERIOD OF PROJECT: Continuous since 1938

PRINCIPAL INVESTIGATOR: James M. Bettendorff

FUNDING: Cooperative--KGS, KNREPC, and other Federal funds from the Corps of Engineers

PROBLEM: Surface-water information is needed for surveillance, planning, design, hazard warning, operation, and management in water-related fields such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water resources development. To provide this information an appropriate data base is necessary.

OBJECTIVE: A. Collect surface-water data sufficient to satisfy needs for current-purpose uses, such as (1) assessment of water resources, (2) operation of reservoirs or industries, (3) forecasting, (4) disposal of wastes and pollution controls, (5) discharge data to accompany water-quality measurements, (6) compact and legal requirements, and (7) research or special studies. B. Collect data necessary for analytical studies to define for any location the statistical properties of, and trends in, the occurrence of water in streams and lakes for use in planning and design.

APPROACH: Standard methods of data collection will be used as described in the series, "Techniques of Water Resources Investigations of the United States Geological Survey." Intermittent streamflow records will be collected instead of continuous records where they serve the required purpose.

PROGRESS: Data were collected on a continuing basis and were published in the Annual Data Report.

PLANS: Continue operations of continuous and intermittent streamflow measurement network and publish records in the Annual Data Report.

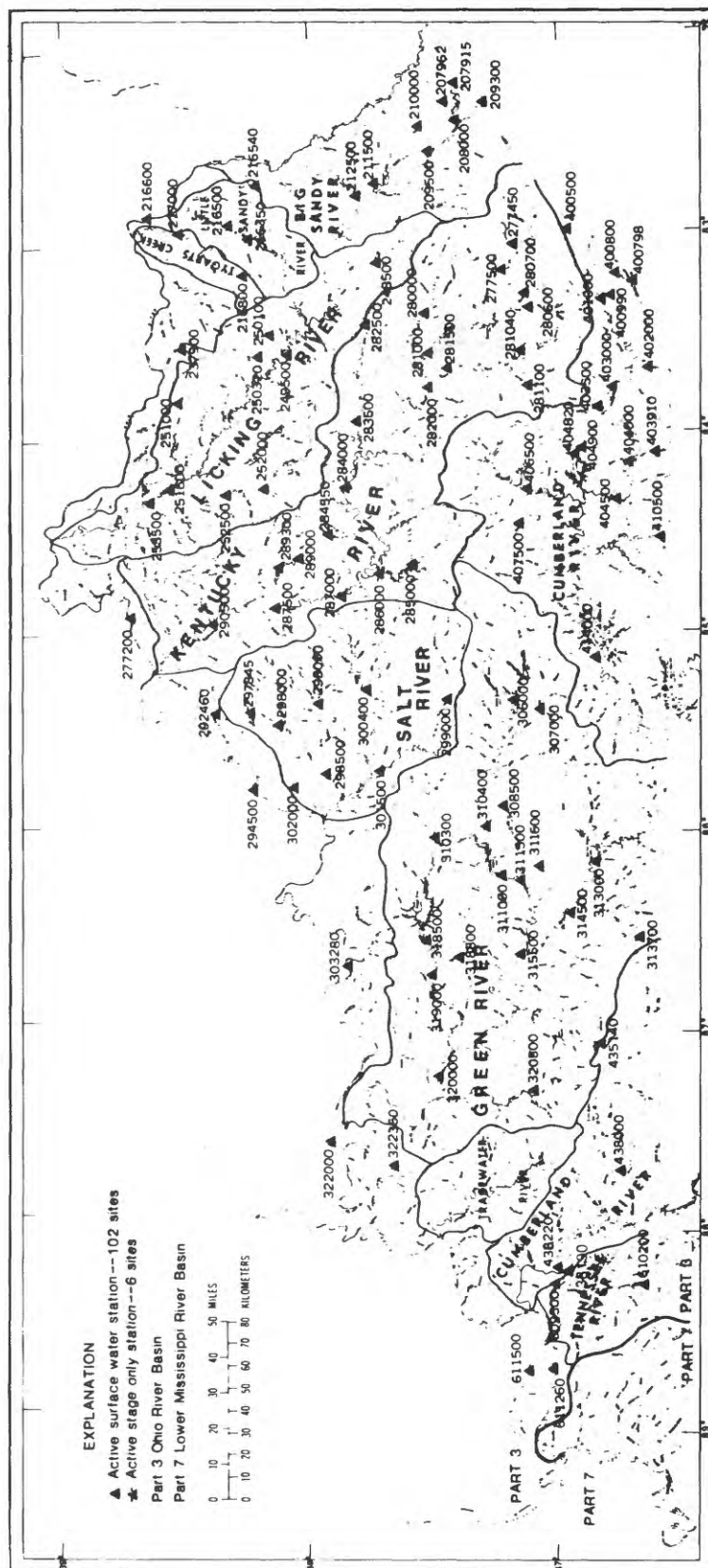
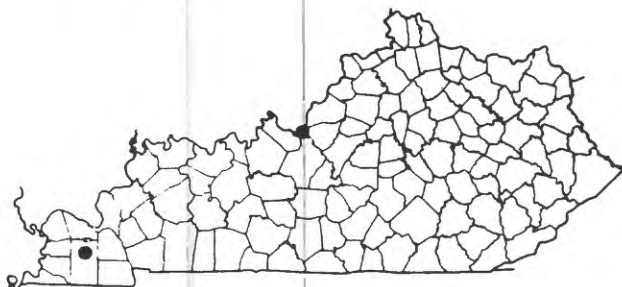


Figure 8.--Location of gaging stations in Kentucky.

KY 00-002 GROUND-WATER STATIONS

LOCATION:

See figure 9 for location of sites in Jefferson County



PERIOD OF PROJECT:

Continuous since January 1949

PRINCIPAL INVESTIGATOR: Douglas D. Zettwoch

FUNDING:

Cooperative--City of Louisville and KNREPC

PROBLEM: Long term water-level records are needed to evaluate the effects of climatic variations on the recharge to and discharge from the ground-water systems, to provide a data base from which to measure the effects of development, to assist in the prediction of future supplies, and to provide data for management of the resource.

OBJECTIVE: A. To collect water-level data sufficient to provide a minimum long-term data base so that the general response of the hydrologic system to natural climatic variations and induced stresses is known and potential problems can be defined early enough to allow proper planning and management. B. To provide a data base against which the short-term records acquired in areal studies can be analyzed. This analysis must (1) provide an assessment of the ground-water resources, (2) allow prediction of future conditions and supply problems, and (3) provide the data base necessary for management of the resource.

APPROACH: Evaluation of regional geology allows broad, general definition of aquifer systems and their boundary conditions. Within this framework and with some knowledge of the stress on the system in time and space and the hydrologic properties of the aquifers a subjective decision can be made on the most advantageous locations for observation of long-term system behavior. This subjective network can be refined as records become available and detailed areal studies of the ground-water system more closely define the aquifers, their properties, and the stresses to which they are subjected.

PROGRESS: Data were collected on a continuing basis and records were published in the Annual Data Report.

PLANS: Continue operation of network and publish records in the Annual Data Report.

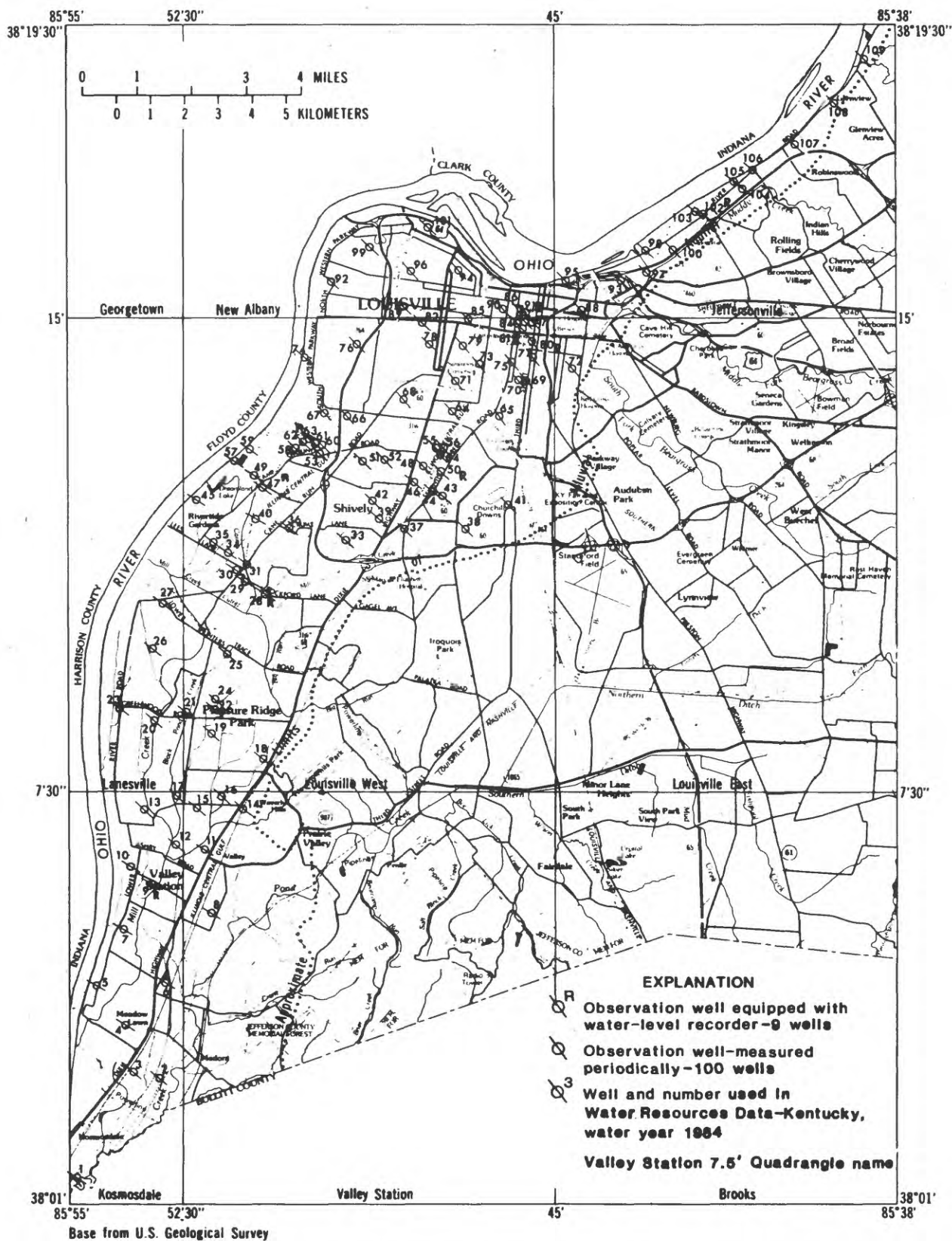
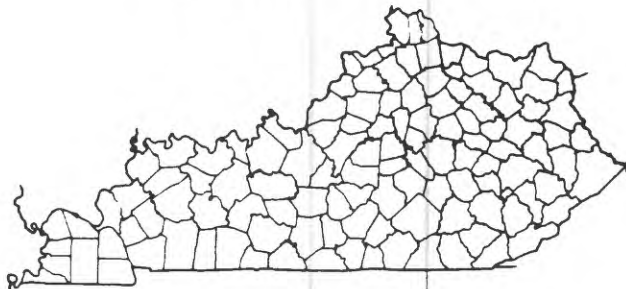


Figure 9.—Location of observation wells in Louisville and Jefferson County area.

KY 00-003 WATER-QUALITY STATIONS

LOCATION:

Statewide--See figure 10 for location of sites



PERIOD OF PROJECT:

Continuous since January 1949

PRINCIPAL INVESTIGATOR:

James L. Smoot

FUNDING:

Cooperative--KNREPC

PROBLEM: Water resources planning and water-quality assessment require a nationwide base level of relatively standardized information. For intelligent planning and realistic assessment of the water resource, the chemical and physical quality of the rivers and streams must be defined and monitored.

OBJECTIVE: The primary objectives of this study are to provide a bank of water-quality data for use in broad Federal and State planning and action programs and to provide data for State and Federal management of intra- and interstate waters.

APPROACH: Operation of a network of water-quality stations to provide average chemical concentrations, loads, and time trends as required by planning and management agencies.

PROGRESS: Data were collected on a continuing basis and records were published in the Annual Data Report.

PLANS: Operate network and publish records in the Annual Data Report.

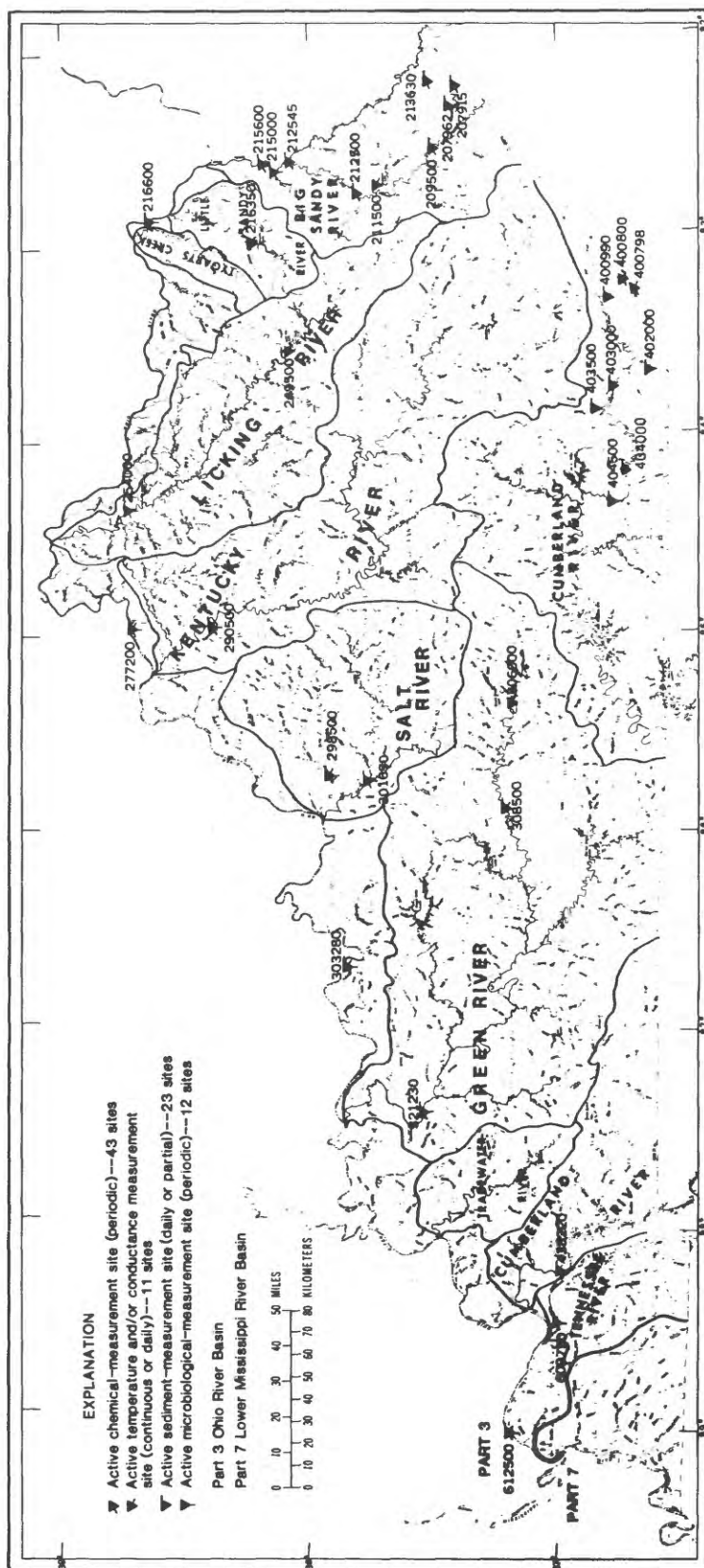


Figure 10.--Location of surface water quality stations in Kentucky.

KY 00-004 SEDIMENT STATIONS

LOCATION:

Statewide--See figure 10 for location of sites



PERIOD OF PROJECT:

Continuous since July 1951

PRINCIPAL INVESTIGATOR:

Clyde J. Sholar

FUNDING:

Cooperative--KGS and other Federal funds from the Corps of Engineers

PROBLEM: Water-resource planning and water-quality assessment require a nationwide base level of relatively standardized information. Sediment concentration and discharges in rivers and streams must be defined and monitored.

OBJECTIVE: The primary objectives of this study are to provide a bank of sediment data for use in broad Federal and State planning and action programs and to provide data for State and Federal management of intra- and interstate waters.

APPROACH: A network of sediment stations is operated to provide spatial and temporal averages and trends of sediment concentration, sediment discharge, and particle size of sediment being transported by rivers and streams.

PROGRESS: Data were collected on a continuing basis and published in the Annual Data Report.

PLANS: Continue operation of network and publish records in the Annual Data Report.

KY 00-005 ATMOSPHERIC DEPOSITION STATION

LOCATION:

Rowan County



PERIOD OF PROJECT:

Continuous since October 1983

PRINCIPAL INVESTIGATOR:

James L. Smoot

FUNDING:

USGS

PROBLEM: To establish and operate a nationwide long-term monitoring network to detect and measure levels of atmospheric deposition.

OBJECTIVE: To determine variations in atmospheric deposition that occurs on a week to week basis. To collect wet and dry deposition products for analysis of elements and compounds that can contribute to the chemical composition of surface waters.

APPROACH: Set up monitoring stations as part of the National Trends Network. Maintain stations, make on-site measurements, process samples, and submit samples to an analytical laboratory. Verify data retrievals and report on results.

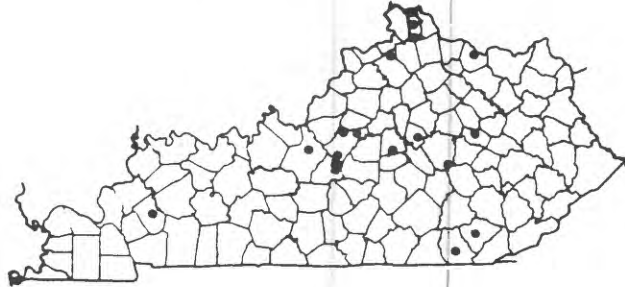
PROGRESS: Data were collected on a continuing basis at one atmospheric deposition station and stored in WATSTORE.

PLANS: Continue the operation of one atmospheric deposition stations and store data in WATSTORE.

KY 76-006 FLOOD INVESTIGATIONS

LOCATION:

Statewide--See map below for location of study sites



PERIOD OF PROJECT:

Continuous since February 1976

PRINCIPAL INVESTIGATOR:

Kevin J. Ruhl

FUNDING:

FEMA

PROBLEM: The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 provides for the operation of a flood insurance program. The Federal Emergency Management Agency (FEMA) needs flood studies in selected areas to determine applicable flood insurance premium rates.

OBJECTIVE: To conduct the necessary hydrologic and hydraulic evaluations and studies of areas assigned by FEMA and to present the results in an appropriate format.

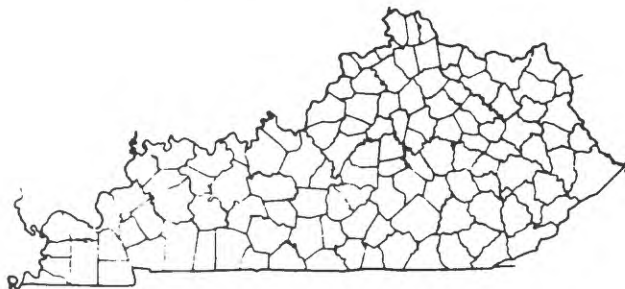
APPROACH: To conduct the necessary evaluations or to conduct surveys by ground or photogrammetric methods. Determine flood-discharge frequency relations using local historical information, gaging-station records, or other applicable information. Determine water-surface profiles using step-backwater models or by other acceptable methods and furnish the results in reports prepared to FEMA specifications.

PROGRESS: The study for Stanton, Ky., was sent to FEMA. The field surveys for Knox and Whitley Counties were completed and most of the data has been entered into computer storage for running the step-backwater program Hy-7.

PLANS: Submit the Whitley County study to FEMA by April 1, 1986 and the Knox County study by June 1, 1986. Studies will start October 1, 1985 in Mercer and Hardin Counties and in the cities of Berea and Nicholasville.

KY 79-007 WATER USE IN KENTUCKY

LOCATION: Statewide



PERIOD OF PROJECT: Continuous since October 1978

PRINCIPAL INVESTIGATOR: Clyde J. Sholar

FUNDING: Cooperative--KNREPC

PROBLEM: The water resources of Kentucky are being used more extensively with each passing year. Although information has been developed as to the occurrence and quality of the resource, relatively little has been done to describe where, how, and in what quantities water is being used. This information is essential to determine how much water remains available for future development and to forecast the time and places of impending water shortages.

OBJECTIVE: The objective of this project is to provide the water-use information for the optimum utilization and management of Kentucky's water resources for the overall benefit of the people of Kentucky. This project will provide for the collection, storage, and dissemination of water-use data to complement data on the availability and quality of the State's water resources. The emphasis in this investigation will be to respond to the data needs of the Kentucky Natural Resources and Environmental Protection Cabinet, the U.S. Geological Survey, other State and Federal agencies, and to local users.

APPROACH: The objective of this investigation will be met by establishing, at State level, facilities for the collection, storage, and dissemination of water-use data. Data collection and storage will be done by the Kentucky Natural Resources and Environmental Protection Cabinet, the State agency that has legislative responsibility for water-use registration in Kentucky.

PROGRESS: Linked Kentucky Department of Natural Resources and Environmental Protection Cabinet, Division of Water, to the District Prime Computer for the purpose of water-use data entry into the input program (KEYDISK) at the State water-use data system (SWUDS). Collected water-use information in a 27-county area in western Kentucky to be published in a report on drought-related impacts on municipal and major self-supplied industrial water withdrawals in western Kentucky.

PLANS: Collect and compile water-use information for each of the 12 categories required by the National Water Use Data System (NWUDS). Complete drought-related water-use study in a 27-county area in western Kentucky and publish report.

KY 75-037 SMALL AREA FLOOD HYDROLOGY

LOCATION:

Statewide--See figure 8 for surface-water network



PERIOD OF PROJECT:

January 1975 to September 1987

PRINCIPAL INVESTIGATOR:

Anne F. Choquette

FUNDING:

Cooperative--Kentucky Transportation
Cabinet and KNREPC

PROBLEM: The magnitude and frequency of floods from rural drainage areas of fewer than 20 square miles is not clearly understood in Kentucky. This lack of knowledge causes severe problems in the efficient design of small drainage structures.

OBJECTIVE: The objectives of this project are to improve the accuracy with which the magnitude and frequency of floods from small rural drainage areas can be estimated, and to enhance the general understanding of flood runoff in Kentucky.

APPROACH: Establish a network of small stream gaging stations consisting of about 65 crest stage partial-record stations, 40 of which will be installed and operated for at least 10 years. In addition, 15 recording rainfall-stage (dual digital) stations will be installed and operated for a period of length sufficient to calibrate the dawdy rainfall-runoff model at each station, probably to 10 years. A flood frequency analysis will be conducted for the flood peak record from each of the above stations plus those for the flood peak record from each of nine existing small stream continuous-record gaging stations. All of the frequency analysis will be regionalized through the use of multiple linear regression analysis; physiographic flood regions, if such are found to exist, will be defined.

PROGRESS: Peak flow data have been collected at 80 sites with CSI gages. Data have been checked for reliability of ratings and agreement with the 1976 regression model estimates of peaks. Ratings were adjusted at selected stations using current discharge measurements. Evaluation of updated flow frequencies and regression model results from 1976 study shows discrepancies at several of the stations tested.

PLANS: Determine peaks at all stations for WY 1985. Input all peak data into WATSTORE. Compile data set on basin characteristics to use in statistical analysis and enter in WATSTORE. Formulate methods for estimating peaks at ungaged sites and work on draft of report. Select 15-20 CSI sites to be continued as long-term stations, and submit proposal to potential cooperators to continue these stations.

KY 83-062 FEASIBILITY OF DISPOSAL IN DEEP CRYSTALLINE ROCKS

LOCATION: Eastern United States



PERIOD OF PROJECT: April 1983 to September 1986

PRINCIPAL INVESTIGATOR: Robert W. Davis

FUNDING: USGS

PROBLEM: High-level radioactive wastes need a permanent repository for disposal that will (1) isolate the wastes from the accessible environment for a long time and protect the wastes from human intrusion, and (2) minimize migration of waste material and be an environment in which direction and velocity of waste migration can be predicted.

OBJECTIVE: (1) To determine if and where buried crystalline rock environments exist which have suitable hydrologic characteristics for isolation of high-level radioactive wastes. (2) To determine if sufficient data exist to screen down to and characterize repository sites within time constraints of the Nuclear Waste Policy Act of 1982.

APPROACH: (1) To review existing data. (2) To define areas east of the 96th meridian where crystalline basement rocks are 1,000 to 4,000 feet below surface. (3) To contact ground-water experts within WRD in defined areas for appraisal of defined area within their competence. (4) To map area above basement of saline water of more than 10,000 mg/L dissolved solids within defined area. (5) To describe present knowledge of ground-water flow system in area defined in (4). (6) To write and process report.

PROGRESS: Have prepared map showing pertinent deep wells in the Cincinnati Arch area, table of wells, and 8 geologic sections showing lithologies of pre-Knox formations.

PLANS: By using lithologic and wire-line logs will attempt to contour thicknesses of very low permeability formations above the basal saline aquifer, and will assist in writing draft of report.

KY 84-063 GROUND-WATER MODEL,
LOUISVILLE, KENTUCKY

LOCATION:

Jefferson County, North
Central Kentucky



PERIOD OF PROJECT:

October 1983 to December 1986

PRINCIPAL INVESTIGATOR:

Mark A. Lyverse

FUNDING:

Cooperative--University of Louisville

PROBLEM: Historically, the alluvial aquifer underlying the Louisville area has been subjected to variable pumping rates, changing water levels, and varying recharge. Since 1962, water levels have risen and caused concern about potential damage to basements and building foundations in and near the downtown area. In 1984, the resumption of ground-water use for heating and cooling began and water management agencies will soon be faced with regulating water use from the aquifer.

OBJECTIVE: (1) To develop a ground-water flow model capable of simulating regional ground-water flow in the alluvial aquifer in the Louisville area. (2) To refine the understanding of the hydrology of the alluvial aquifer in the area. (3) To compare management alternatives of various pumping configurations. This project is the initial step in modeling the Louisville area. Based on the results of this project, more detailed modeling may be desirable involving a solute-transport simulation model to assess potential water-quality problems that may develop in the Louisville-Jefferson County metropolitan area. Additionally, water management agencies may use the ground-water flow model to assist in regional water-use planning and decision making.

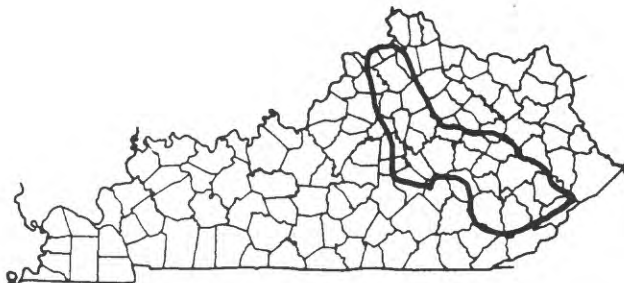
APPROACH: Design a conceptual model from existing data describing the hydrologic system. Construct a two dimensional flow model to simulate ground-water flow. Modify the calibrated model for convenient use by water management agencies.

PROGRESS: Developed and calibrated coarse-grid model for the study area. Continued to collect infiltration data at two sites.

PLANS: Continue calibration work on a fine-grid model of the study area.

KY 84-065 TRAVEL TIMES FOR STREAMS IN
KENTUCKY RIVER BASIN

LOCATION: Kentucky River basin in
East Central Kentucky



PERIOD OF PROJECT: October 1983 to September 1986

PRINCIPAL INVESTIGATOR: James L. Smoot

FUNDING: Cooperative--KGS

PROBLEM: Stream reaeration coefficients are used in stream water-quality models to forecast the effects of organic loadings on dissolved-oxygen concentrations along stream channels. The reaeration coefficients have been estimated by State agencies from theoretical, semi-empirical, or empirical equations, each of which have disadvantages. Recent advances in the modified-tracer method appear to offer a less costly and more accurate, reliable, and reproducible method of measuring reaeration coefficients within streams. Now, because of more stringent water-quality standards, there is a real and immediate need to determine reliable reaeration coefficients.

OBJECTIVE: 1. Develop techniques by which reaeration coefficients for streams may be reliably estimated using easily measured physical and hydraulic characteristics of a stream channel. 2. Develop techniques by which time-of-travel characteristics for streams may be reliably estimated using easily measured physical and hydraulic characteristics of a stream channel. 3. To formulate a data base for use in developing regional equations for estimating the reaeration coefficients of various streams in the Kentucky River basin. 4. Compile data on measured stream geometry for use in other hydrologic studies.

APPROACH: The gas and dye tracer techniques will be used to determine reaeration coefficients and travel times in three types of stream reaches. Multiple regression will be used to develop equations for reaeration coefficients and time of travel for each type of reach. Measured values of reaeration coefficients, velocities of leading edge and peak concentration as defined by the centroid of the dye cloud, duration of dye cloud, and unit concentration of a conservative contaminant will be the dependent variables and the physical and hydraulic properties of the stream will be the independent variables. Partial-correlation coefficients will be used to select the most important independent variables. The statistical significance of independent variables and standard errors of the resultant equations will be determined.

PROGRESS: Time of travel, dispersion and reaeration field studies were performed on five selected streams in the Kentucky River basin. Additional field studies were made on three other stream reaches under a variety of flow conditions. Computer software for data handling, calculations, plotting, and analysis was developed and verified. Literature review was completed.

PLANS: Complete field studies on selected stream reaches and analysis of all field data and prepare final report on project results.

KY 84-066 THE IMPACT OF SINKHOLES AND STREAMS ON
GROUND-WATER FLOW IN A CARBONATE AQUIFER
SYSTEM, NEAR ELIZABETHTOWN, KENTUCKY

LOCATION: Hardin County, North Central
Kentucky



PERIOD OF PROJECT: June 1984 to September 1986

PRINCIPAL INVESTIGATOR: Donald S. Mull

FUNDING: Cooperative--City of Elizabethtown

PROBLEM: Carbonate aquifers are used extensively for public, industrial and domestic water supplies in the Elizabethtown area. These aquifers are easily polluted by direct recharge through openings in bedrock. Sound land-use planning, development, and protection of water supplies depends on the identification of sinkholes open to the subsurface and the relation between drainage from sinkholes and streams and the ground-water system.

OBJECTIVE: The overall objective is to locate and classify sinkholes and losing streams that can affect the ground-water supply of Elizabethtown. This will be done by providing a report with maps and illustrations that show the connection between sinkholes, sinking streams, and the city springs and wells during high and low flow conditions. Dye tracing will define travel time and peak concentrations during high and low-flow conditions. In addition, stage-discharge relation will be defined at each sampling site.

APPROACH: 1. Review and analyze existing data. 2. Map and classify sinkholes, especially along major transportation arteries that cross the recharge area for the city wells and springs. 3. Select sinkholes for dye tracing. 4. Perform dye tracing during high and low flow conditions. 5. Analyze data to determine peak concentrations and passage-time of the dye cloud. Prepare time-concentration and travel-time distance curves for selected sites. 6. Perform flow-net analysis to define direction and rate of ground-water movement. 7. Perform seepage runs and dye tracing in Valley Creek.

PROGRESS: Located major sinkholes contributing water to city springs, and defined travel time at various flow conditions. Travel times varied from 4 to 24 hours depending on flow conditions. Low-flow measurements in headwaters of Valley Creek indicate that it is a gaining stream in that part of the study area.

PLANS: Complete dye tracing between selected sinkholes and city wells and springs during high flow. Analyze all data and prepare report.

KY 85-068 SEDIMENTATION AND EROSION RATES AT
THE MAXEY FLATS RADIOACTIVE WASTE BURIAL
SITE, FLEMING COUNTY, KENTUCKY

LOCATION:

Fleming County, North-
eastern Kentucky



PERIOD OF PROJECT:

October 1984 to September 1987

PRINCIPAL INVESTIGATOR:

Mark A. Lyverse

FUNDING:

USGS

PROBLEM: Increased flow from the plastic covered surface at Maxey Flats radioactive waste burial site has changed the sediment-transport competence of stream channels when compared to natural surface runoff. Consequently, the rates of erosion and gully formation along the hillsides have been altered. Estimates for the rate of slope retreat and trench cap erosion are needed for management of the site.

OBJECTIVE: The primary objectives of the study are to measure the fluvial processes and mass movement occurring at the waste burial site and to compare and evaluate data on erosion measured at the site with data calculated from various sediment-transport equations.

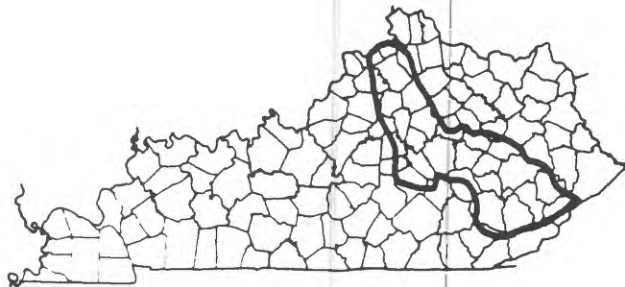
APPROACH: 1. Detachment of sediment on the upland areas will be measured using lines of erosion pins. 2. Sediment delivery by the ephemeral streams discharging from the site to perennial streams downstream will be measured by sampling for suspended sediment using automatic stage-activated samples. 3. Sediment-yield and transport equations will be evaluated to determine their applicability to erosional processes at Maxey Flats.

PROGRESS: Installed erosion pins in lines on the steep slopes bordering the burial sites. Overland runoff samples are now being collected and sent to the Iowa lab for analysis.

PLANS: Complete instrumentation for project which will include upgrading an existing gaging station or installing a new one for collecting sediment data. Continue to collect sediment samples and measure erosion rates.

KY 85-069 GROUND-WATER HYDROLOGY IN
THE KENTUCKY RIVER BASIN

LOCATION: Kentucky River basin in
East Central Kentucky



PERIOD OF PROJECT: October 1984 to September 1989

PRINCIPAL INVESTIGATOR: Robert J. Faust

FUNDING: Cooperative--KGS

PROBLEM: The Kentucky River basin of Kentucky (fig. 1) is an area of population and economic growth, especially in the Lexington-Fayette County area. Our knowledge of ground water in most of the basin is 30 years old. In order to satisfy the needs of planners and others and to assist in the orderly development of the Kentucky River basin, there is a need for additional up-to-date data on water resources in this area. This includes data on yields, availability, quality of water, land use effects, and a better understanding of the geologic and hydrologic principles that determine ground-water characteristics.

OBJECTIVE: The overall objective of the project is to increase our understanding of the distribution, occurrence, quantity, and quality of ground water in the Kentucky River basin. Specific objectives are: (1) outline areas of large-yielding wells, (2) assess the occurrence, movement and interaction of surface and ground water in the oil and gas producing areas, (3) define the occurrence and movement of potable ground water in the Blue Grass Region, (4) appraise ground-water quality trends, (5) analyze ground water for trace constituents, bacteriological components, and organic contaminants, and (6) enter new existing well data in the GWSI system.

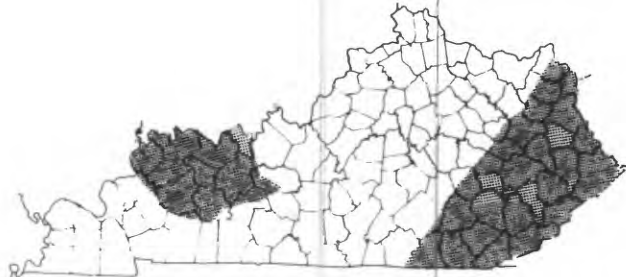
APPROACH: (1) Inventory and describe setting of large-yielding wells. (2) Determine the stratigraphy of petroleum producing areas and describe water quality in the areas. (3) Develop a conceptual model of shallow ground water flow from potentiometric measurements and dye tracing. (4) Analyze trends in ground-water quality by resampling wells with existing quality of water data. (5) Develop and sample a network for constituents, bacteria, and organics. (6) Enter pertinent old data and new data in computer storage.

PROGRESS: Entered about 1100 wells and springs into GWSI from our files. Data collection was concentrated in the upper part of the Kentucky River basin and consisted of updating the well inventory, collecting samples to determine the magnitude and extent of high barium concentrations, and establishing networks to study the effects of oil and gas production on water quality.

PLANS: Continue to update the well inventory and enter into GWSI. Analyze data to determine the occurrence, magnitude, and extent of high barium concentrations, and collect data to study the effects of oil and gas production on water quality.

KY 85-070 A TECHNIQUE FOR EVALUATING THE CUMULATIVE
IMPACTS OF MINING AS APPLIED TO
THE COAL FIELDS OF KENTUCKY

LOCATION: Eastern Kentucky



PERIOD OF PROJECT: October 1984 to September 1989

PRINCIPAL INVESTIGATOR: James L. Kiesler, Jr.

FUNDING: Cooperative--KNREPC

PROBLEM: (1) Can the calibration characteristics of a watershed model, HSPF, be related to topographic, geologic, or geographic features easily identifiable from field or literature investigations? (2) How can HSPF be made "easy to use" in order to give those unfamiliar with the model a simple and efficient tool for evaluating the cumulative impacts of mining?

OBJECTIVE: (1) Locate, catalog, and compile sources of hydrologic data that can be used to calibrate the HSPF model. (2) Calibrate the model at selected sites in the coal regions of Kentucky. (3) Regionalize selected model calibration characteristics. (4) Document a procedure so those unfamiliar with HSPF can use the regionalized model values to simulate the hydrology of mined areas.

APPROACH: A search will be made of other Federal, State, and local agencies for data that can be used to calibrate the model. The model will be calibrated at about 30-40 sites in the Kentucky coal fields. Two-thirds of the sites will be used to regionalize model values. The remaining will be used to verify that the regionalized values will work. A report describing the procedure for using the regionalized values will be done.

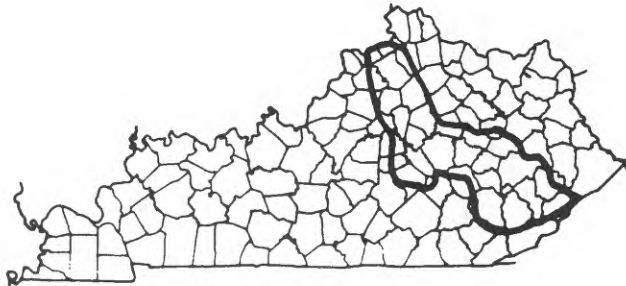
PROGRESS: Part of the year was spent developing a work plan and reviewing literature. Data were gathered to be used in developing a procedure for determining the increase in the availability of iron, manganese, and sulfate caused by mining. Began calibrating a model for a small watershed in Pike County.

PLANS: Will attempt to calibrate HSPF model at 15 sites in Eastern Kentucky coal field and will start developing regional values for calibration parameters.

KY 86-071 SURFACE WATER QUALITY ASSESSMENT
OF THE KENTUCKY RIVER BASIN, KENTUCKY
(HYDROLOGIC ACCOUNTING UNIT 051002)

LOCATION:

Kentucky River basin in
East Central Kentucky



PERIOD OF PROJECT:

March 1986 to March 1990

PRINCIPAL INVESTIGATOR:

James L. Smoot

FUNDING:

USGS

PROBLEM: The Kentucky River basin is the most densely populated river basin in Kentucky and is projected to be the area of most growth in 430 sites in the basin by the U.S. Geological Survey, the U.S. Army Corps of Engineers, the Environmental Protection Agency, the Office of Surface Mining, and the U.S. Forest Service, as well as various State agencies specifically mandated to enforce water-quality standards. These data have not been evaluated on a regional basis. There is, therefore, a basic need for a regional assessment of the temporal and spatial variability in these data to delineate water-quality trends and problems. Such a study will aid those charged with prioritizing the monitoring, regulation, legislation, and mitigation of water-quality problems in the basin, as well as identify present and emerging water-quality impacts.

OBJECTIVE: The objective of this study is to increase our understanding of the regional and historic variability of water-quality in the Kentucky River basin and to identify both the sources and processes that significantly contribute to water-quality degradation in the basin. This will be accomplished by synthesizing the available data base on a regional scale and by supplementing the existing data base with additional fixed station and synoptic sampling to better define the extent and seasonality of apparent problems. The results will allow us to evaluate the adequacy of the existing sampling network for describing water-quality in the basin and to identify any additional sampling or monitoring requirements.

APPROACH: The initial task of the study is to assess the existing water-quality data that are readily available. A cursory analysis of basin land use will also be made to identify general areas of the basin where specific land-use related non-point sources of pollution occur. A fixed-point, fixed-interval sampling network will be established. The site selection will be made to augment the existing State network and to adequately cover areas of the basin affected by non-point sources (principally from coal mining, agriculture, and oil and gas production).

Synoptic studies of the basin would be done early in the first year of study both during high-flow and low-flow periods. The high-flow study results will be used to adjust the fixed-point sampling network to best reflect the non-point sources (assuming that high flow is usually the critical period for non-point sources). Constituents sampled will coincide with those anticipated that would be transported from non-point sources. The initial low-flow synoptic study will concentrate on defining the basin effects from point sources and will be used for network refinements.

The synoptic studies, along with others, would be used to identify water quality problem areas in the basin. The most severe problem areas will then be studied in detail on a small scale to define the characteristics of the source/effect relations. These detailed studies would attempt to define the environmental roles determining the fate of the problem constituents.

The fixed-station fixed-interval sampling will be used along with any historical data to develop and track water-quality trends. A base level of data collection at these network sites would be anticipated to continue beyond the study period to provide a historical data base for use in future basin studies.

PROGRESS: Project proposal was prepared and approved for start of study in FY-86.

PLANS: Assimilate data, prepare detailed work plan, establish a sampling network, and begin synoptic sampling during high and low base flow conditions.

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Open-file reports which may be in manuscript form, generally are not reproduced and distributed in quantity. These reports are available for inspection in the Louisville, Kentucky, and Reston, Virginia, offices of the U.S. Geological Survey. Most numbered open-file reports may be purchased from the Open-File Services Section (OFSS), Western Distribution Branch, U.S. Geological Survey, Box 25425, Federal Center, Lakewood, Colorado 80225. Information on the availability of the un-numbered reports may be obtained from the District Chief, U.S. Geological Survey, Water Resources Division, Stoddard Johnston Building, 2301 Bradley Avenue, Louisville, Kentucky 40217.

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OTHER HYDROLOGIC WORK BY THE DISTRICT

As part of its responsibility to provide information on water to all water users, the Geological Survey is involved in numerous other activities in addition to regular programs of data collection and hydrologic investigations. One of these functions is to serve as a Federal or Survey representative on advisory committees or ad hoc groups set up for specific purposes. Some of the current special activities are described below:

Committee and Task Force memberships.--Members of the District Staff are working members and advisors to several committees and task forces. Included are the Ground-Water Advisory Council of the Governor, the Advisory Committee of the Ohio River Basin Commission and the Council of State Governments, the Drought Monitoring Advisory Committee, Louisville Ground-Water Development Task Force, and the Ohio River Valley Water Sanitation Commission (ORSANCO) Monitoring Strategy Committee.

Review of Environmental Impact Statements and other agency reports.--The Water Resources Division reviews Environmental Impact Statements for Federal airport and highway projects to insure that available hydrologic data are used, that they are used correctly, and that the impacts of construction on water features and resources is accurately evaluated. From time to time, the District is also asked to review reports and projects of other Federal agencies, primarily because of the Survey's hydrologic expertise and impartiality.

OTHER HYDROLOGIC WORK BY THE DISTRICT--Continued

Assistance to other agencies and individuals.--In addition to the Survey's formal programs and studies, water information and assistance are provided other agencies with specific problems. The District continually receives calls, visits, and mail requests for information on ground-water availability, stream-flow data, and water quality from landowners, consultants, public officials, and business concerns. Federal regulations prohibit activity that encroaches on the work of professional consultants, but much information and assistance are provided to professional engineers, geologists, and other consultants.

SOURCES OF WATER RESOURCES INFORMATION IN THE U.S. GEOLOGICAL SURVEY

Hydrologic Information Unit

Questions about water resources in general or about the water resources of specific areas of the United States can be directed to the Hydrologic Information Unit. This office will also answer inquiries about the availability of reports of water-resources investigations.

Hydrologic Information Unit
U.S. Geological Survey
420 National Center
Reston, Virginia 22092

Kentucky Water Resources

Questions specific to water resources in Kentucky can be directed to the Kentucky District Office. This office will answer inquiries about reports and other Kentucky water-resources publications.

Alfred L. Knight
U.S. Geological Survey
Stoddard Johnston Building
2301 Bradley Avenue
Louisville, Kentucky 40217

SOURCES OF WATER RESOURCES INFORMATION IN THE U.S.
GEOLOGICAL SURVEY--Continued

Office of Water Data Coordination

The OWDC (Office of Water Data Coordination) is the focal point for interagency coordination of ongoing and planned water-data acquisition activities of all Federal agencies and many non-Federal organizations. The "National Handbook of Recommended Methods for Water-Data Acquisition," indexes to the "Catalog of Information on Water Data," and other publications are available from OWDC. For further information, write:

Office of Water Data Coordination
U.S. Geological Survey
417 National Center
Reston, Virginia 22092

National Water Data Exchange

NAWDEX (National Water Data Exchange) maintains a computerized data system that identifies sources of water data and indexes information on the water data available from the sources. The NAWDEX Program Office and local Assistance Centers assist data users in locating sources of water data, identifying sites at which data have been collected, and obtaining specific data. For further information, write:

National Water Data Exchange
U.S. Geological Survey
421 National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092

National Water Data Storage and Retrieval System

WATSTORE (National Water Data Storage and Retrieval System) is the water data base of the U.S. Geological Survey. It contains data on stream discharge (flow) and stage (height), reservoir and lake storage, ground-water levels, well and spring discharge, and the quality of surface and ground water. For information about types and acquisition of data, write:

Alfred L. Knight
U.S. Geological Survey
Stoddard Johnston Building
2301 Bradley Avenue
Louisville, Kentucky 40217

SOURCES OF WATER RESOURCES INFORMATION IN THE U.S.
GEOLOGICAL SURVEY--Continued

Public Inquiries Offices

USGS Public Inquiries Offices in the following cities provide general information about the Geological Survey's programs and its publications; and they sell, over the counter, maps of local and general interest:

USGS Public Inquiries Office
1100 Commerce Street
Room 1-C-45 Federal Building
Dallas, Texas 75242
Phone: (214) 767-0198

*USGS Public Inquiries Office
12201 Sunrise Valley Drive
Room 1-C-402, 503 National Center
Reston, Virginia 22092
Phone: (703) 860-6167

USGS Public Inquiries Office
1961 Stout Street
169 Federal Building
Denver, Colorado 80294
Phone: (303) 837-6167

*USGS Public Inquiries Office
19th and F Streets, NW
Room 1028 General Services Building
Washington, DC 20244
Phone: (202) 343-8073

*The Reston and Washington PIO's sell maps of all the States and most USGS Books.

SOURCES OF U.S. GEOLOGICAL SURVEY PUBLICATIONS

Books, Maps, and Periodicals

Since 1879, the U.S. Geological Survey has served the public and Federal, State, and local governments by collecting, analyzing, and publishing detailed information about the Nation's mineral, land, and water resources. This information is in a variety of map, book, and other formats and is available from several sources within the Geological Survey.

Books, Catalogs, and Pamphlets

To order USGS book publications, catalogs*, and pamphlets, write:

Text Products Section, Eastern Distribution Branch,
U.S. Geological Survey,
604 South Pickett Street, Alexandria, Virginia 22304

SOURCES OF U.S. GEOLOGICAL SURVEY PUBLICATIONS--Continued

Maps

To order maps of areas east of the Mississippi River (including Minnesota, Puerto Rico, and the Virgin Islands), write:

Eastern Distribution Branch, U.S. Geological Survey,
1200 South Eads Street, Arlington, Virginia 22202

To order maps of areas west of the Mississippi River (including Alaska, Hawaii, Louisiana, Guam, and Samoa), write:

Western Distribution Branch, U.S. Geological Survey,
Box 25286, Federal Center, Denver, Colorado 80225

New Publications

To get on the mailing list for the free monthly catalog, "New Publications of the Geological Survey," write:

Mailing List Unit, U.S. Geological Survey,
582 National Center, Reston, Virginia 22092

Open-File Reports

For information on the availability of microfiche or paper duplicate copies of selected open-file reports, write:

Open-File Services Section, U.S. Geological Survey,
Box 25425, Federal Center, Denver, Colorado 80225

*Two cumulative catalogs (1879-1961 and 1962-1970) sell for \$2.00 each. The annual catalogs for 1971 and subsequent years are free. See "New publications of the Geological Survey" above for information about the monthly catalogs.